DECLARATION OF ROBERT A. LIEBERMAN

I, Robert A. Lieberman declare as follows:

The following demonstrates how a person of ordinary skill in the art would be able to implement the apparatus described and claimed in application S.N. 10/717,080. Given the information in the patent application specification a person skilled in the art would have the knowledge to alter fiber optic properties (e.g., core/cladding refractive index, absorption coefficients, and scattering coefficient.) in such a way as to achieve constant power loss per unit length over the entire fiber. Further, using a similar analytic method applying the relevant relationships the diameter variation to achieve constant power loss per unit length can also be shown to be within the skill of a person skilled in the art.

In the case where the parameter to be varied is the core/cladding refractive index ratio, begin at equation (1) of the specification:

(A) $$P \approx P_o \frac{V}{\alpha l}$$

where P is the power carried by the fiber, P_o is the original power launched in the fiber, α is the attenuation coefficient, l is the distance from the launch point, and V is the well-known waveguide parameter or "V-number," defined by:

(B) $$V = Ka\sqrt{n_{Co}^{2} - n_{Cl}^{2}}$$

where n_{Co} is the core refractive index, n_{Cl} is the cladding refractive index, a is the fiber core radius, and k is the wavenumber (directly related to the wavelength of light being transmitted by the fiber).

It is obvious to one skilled in the art that the condition for constant power loss as a function of length is that the first derivative of P with respect to length should be constant. Thus

(C) $$\frac{dP}{dl} = -\frac{P_o V}{\alpha l^2} = constant$$

One means of achieving this is to adjust the V number so that it becomes a quadratic function of length, i.e.:

(D) $$V = Al^2$$

where A is an arbitrary constant. Using equation (C) above, this means that the core and cladding of the optical fiber have to have the following relation to one another:

$$\text{(E)} \qquad n_{Cl}^{\ 2} = n_{Co}^{\ 2} - \frac{A^2}{K^2 a^2} l^4$$

Putting equation (D) into equation (A) yields, through equation B,

$$\text{(F)} \qquad P = P_o \frac{A}{\alpha} l$$

Equation (F) shows that, for the choice of indices in (E), power varies constantly with length.

In the case where the parameter to be varied is the absorption coefficient, the power loss can be linearized by creating a structure with an absorption coefficient that is higher at the input end, and progressively lower further from the input end. Starting at equation (A) above, it is obvious to one skilled in the art that, if the attenuation, a, is made to be directly proportional to the reciprocal of the length parameter, l, then the power in the fiber remains constant over the length of the fiber (i.e., P will be independent of l). The absorption coefficient is the product of the innate optical absorbance of an optically absorbing substance and the concentration of that substance. Thus, linearization can be accomplished by introducing into the fiber an optically absorbing material at a length-varying concentration, i.e.,

$$(G) \qquad C_a(l) = C_{a0} / l,$$

where $C_a(l)$ is the concentration of the absorbing substance as a function of length and C_{a0} is the concentration of the absorbing substance at the input end.

In the case where the parameter to be varied is the scattering coefficient, and the desire is to create a uniform coupling of optical power to the fiber cladding (e.g., for chemical sensing) the situation is reversed: increased scattering is needed as light travels farther from the input end. Thus, the concentration of scattering substance should follow the relation in equation (H) below:

$$(H) \quad Cs(l) = C_{s0} \cdot l,$$

where $C_a(l)$ is the concentration of the scattering centers as a function of length, and C_{a0} is the concentration of the scattering centers at the input end of the fiber.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

RA Lieb 11/5/04

Robert A. Lieberman Date